



Following is a list of the claims presented in this application:

1. (Original) A method for removing material from a face surface of a microelectronic substrate, comprising:

engaging the microelectronic substrate with a polishing surface of a polishing pad;

electrically coupling a conductive material of the microelectronic substrate to a source of electrical potential by positioning first and second electrodes proximate to and spaced apart from the face surface of the microelectronic substrate and disposing an electrolytic fluid between the face surface and the electrodes while the face surface is engaged with the polishing surface of the polishing pad, with both the electrodes in fluid communication with each other and the electrolytic fluid;

oxidizing at least a portion of the conductive material by passing an electrical current through the conductive material from the source of electrical potential;

and

removing the portion of the conductive material from the microelectronic substrate by moving at least one of the microelectronic substrate and the polishing pad relative to the other.

RECEIVED

APR 07 2003

TECHNOLOGY CENTER R3700

2. (Original) The method of claim 1, further comprising facing both the first and second electrodes toward the face surface of the microelectronic substrate, with one of the electrodes defining an anode and the other electrode defining a cathode.

3. (Original) The method of claim 1 wherein passing an electrical current through the conductive material includes passing an electrical current at a potential of up to at least about 100 volts.

4. (Original) The method of claim 1 wherein passing an electrical current includes passing a current of from about 1 amp to about 10 amps.

5. (Original) The method of claim 1, further comprising controlling an oxidation rate of the conductive material by controlling characteristics of the electrical current passing through the conductive material.

6. (Original) The method of claim 1, further comprising controlling an oxidation rate of the conductive material by controlling at least one of a frequency and an amplitude of the electrical current passing through the conductive material.

7. (Original) The method of claim 1, further comprising halting removal of the conductive material from the microelectronic substrate by halting a flow of electrical current through the conductive material.

8. (Original) The method of claim 1, further comprising:
selecting the electrolytic fluid to have no discrete abrasive elements; and
selecting the polishing pad to have no discrete abrasive elements.

9. (Original) The method of claim 1, further comprising selecting the electrolytic fluid to include chloride ions having a concentration of from about 50 ppm to about 5,000 ppm.

10. (Original) The method of claim 1, further comprising selecting the polishing pad to include a plurality of abrasive elements fixedly attached to the polishing pad at least proximate to the polishing surface.

11. (Original) The method of claim 1, further comprising selecting the electrolytic fluid to include a plurality of suspended abrasive elements.

12. (Original) The method of claim 1, further comprising selecting the conductive material to include a metal.

RECEIVED
APR 07 2003
TECHNOLOGY CENTER R3700

13. (Original) The method of claim 1, further comprising selecting the conductive material to include at least one of rhodium, iridium, gold, platinum, copper, tantalum, tungsten and titanium.

14. (Original) The method of claim 1, further comprising disposing a liquid between the conductive material and the polishing surface of the polishing pad, the liquid including at least one of $(\text{NH}_4)_2\text{SO}_4$, H_2SO_4 , K_2SO_4 , MgSO_4 , and H_3PO_4 .

15. (Original) The method of claim 1 wherein removing material from the microelectronic substrate includes removing the material anisotropically in a direction generally transverse to the polishing surface of the polishing pad.

16. (Withdrawn)

17. (Original) The method of claim 1, further comprising controlling a rate at which material is removed from the microelectronic substrate by controlling a concentration of chloride ions in the electrolytic fluid.

18. (Original) The method of claim 1, further comprising controlling a rate at which material is removed from the microelectronic substrate by controlling a concentration of alcohol in the electrolytic fluid.

19. (Original) The method of claim 1, further comprising selecting the conductive material to include a semiconductor material.

20. (Original) The method of claim 19, further comprising selecting the conductive material to include polysilicon.

21. (Original) The method of claim 19, further comprising selecting the conductive material to include polysilicon doped with phosphorous or boron.

22. (Original) A method for removing a conductive material from a microelectronic substrate, comprising:

engaging a face surface of the microelectronic substrate with a polishing surface of a polishing pad;

disposing a liquid adjacent to the polishing surface of the polishing pad, the liquid including at least one of $(\text{NH}_4)_2\text{SO}_4$, K_2SO_4 , H_2SO_4 , MgSO_4 , H_3PO_4 , and ammonium citrate;

electrically coupling the conductive material to a source of electrical potential; and

moving at least one of the microelectronic substrate and the polishing pad relative to the other while the polishing surface is engaged with the microelectronic substrate to remove material from the face surface of the microelectronic substrate.

23. (Original) The method of claim 22, further comprising:

positioning first and second electrodes spaced apart from the face surface of the microelectronic substrate and in fluid communication with the liquid; and

coupling at least one of the electrodes to a source of electrical potential with one of the electrodes defining an anode and the other defining a cathode.

24. (Original) The method of claim 22, further comprising selecting the liquid to include chloride ions having a concentration of from about 50 ppm to about 5,000 ppm and disposing the liquid between the polishing surface of the polishing pad and the surface of the microelectronic substrate.

25. (Original) The method of claim 22, further comprising selecting the liquid and the polishing pad to have no discrete abrasive elements.

26. (Original) The method of claim 22, further comprising selecting the liquid adjacent to the polishing surface of the polishing pad to include $(\text{NH}_4)_2\text{SO}_4$ having a concentration of from about 1M to about 5.5M.

27. (Original) The method of claim 22, further comprising selecting the liquid adjacent to the polishing surface of the polishing pad to include H_2SO_4 having a concentration of up to about 0.5M.

28. (Original) The method of claim 22, further comprising controlling a pH of an environment adjacent to the conductive material to be from about 1 to about 14 when the conductive material includes platinum, less than about 3 or greater than about 4 when the conductive material includes tungsten, and less than about 6 or greater than about 8 when the conductive material includes copper.

29. (Original) The method of claim 22, further comprising selecting the conductive material of the microelectronic substrate to include a metal.

30. (Original) The method of claim 22, further comprising selecting the conductive material of the microelectronic substrate to include platinum.

31. (Original) The method of claim 22, further comprising selecting the conductive material of the microelectronic substrate to include a doped semiconductor material.

32. (Original) The method of claim 22 wherein removing material from the microelectronic substrate includes removing the material anisotropically in a direction generally transverse to the surface of the microelectronic substrate.

33. (Original) A method for removing platinum from a face surface of a microelectronic substrate, comprising:

engaging a platinum portion of the face surface of the microelectronic substrate with a polishing surface of a polishing pad;

applying an electrical current to the platinum portion by positioning first and second electrodes proximate to and spaced apart from the face surface and disposing an electrolytic fluid between the face surface and the electrodes while the

microelectronic substrate is engaged with the polishing pad, with both the electrodes in fluid communication with the electrolytic fluid; and

anisotropically removing at least part of the platinum portion from the microelectronic substrate by moving at least one of the microelectronic substrate and the polishing pad relative to the other while the microelectronic substrate is engaged with the polishing pad and while applying the electrical current to the platinum portion.

34. (Original) The method of claim 33, further comprising:
selecting the electrolytic fluid to have no discrete abrasive elements; and
selecting the polishing pad to have no discrete abrasive elements.

35. (Original) The method of claim 33, further comprising selecting the electrolytic fluid to include chloride ions having a concentration of from about 50 ppm to about 5,000 ppm.

36. (Original) The method of claim 33 wherein applying an electrical current to the platinum portion includes applying an electrical current at a potential of up to at least about 100 volts.

37. (Original) The method of claim 33 wherein applying an electrical current includes applying an electrical current of from about 1 amp to about 10 amps.

38. (Original) The method of claim 33, further comprising controlling an oxidation rate of the platinum portion by controlling characteristics of the electrical current applied to the platinum portion.

39. (Original) The method of claim 33, further comprising controlling an oxidation rate of the platinum portion by controlling at least one of a frequency and an amplitude of the electrical current applied to the platinum portion.

40. (Original) A method for removing conductive material from a microelectronic substrate, comprising:

engaging the conductive material of the microelectronic substrate with a polishing surface of a polishing pad;

moving at least one of the microelectronic substrate and the polishing pad relative to the other while the microelectronic substrate is engaged with the polishing pad and while applying a varying electrical current to the conductive material; and

controlling a pH of an environment adjacent to the conductive material to be from about 1 to about 14 when the conductive material includes platinum, less than about 3 or greater than about 4 when the conductive material includes tungsten, and less than about 6 or greater than about 8 when the conductive material includes copper.

41. (Original) The method of claim 40 wherein the conductive material is disposed on a face surface of the microelectronic substrate, and wherein applying an electrical current to the conductive material includes positioning first and second electrodes facing toward the face surface, with one of the electrodes defining an anode and the other electrode defining a cathode, and disposing an electrolytic fluid between the face surface and the first and second electrodes.

42. (Original) The method of claim 40 wherein removing the conductive material includes anisotropically removing at least part of the conductive material.

43. (Original) The method of claim 40 wherein applying an electrical current includes positioning first and second electrodes proximate to the conductive material, disposing an electrolytic fluid between the electrodes and the conductive material, and coupling the at least one electrode to a source of electrical potential, with the first and second electrodes in fluid communication with the electrolytic fluid.

44. (Original) The method of claim 40, further comprising selecting the electrolytic fluid to include at least one of $(\text{NH}_4)_2\text{SO}_4$, H_2SO_4 , MgSO_4 , and H_3PO_4 .

45. (Original) The method of claim 40, further comprising selecting the electrolytic fluid and the polishing pad to have no discrete abrasive elements.

46. (Original) The method of claim 40, further comprising selecting the electrolytic fluid to include chloride ions having a concentration of from about 50 ppm to about 5,000 ppm.

47. (Original) A method for removing conductive material from a face surface of a microelectronic substrate, the conductive material being capable of oxidizing at a first rate when exposed to an oxidizing chemical agent, the method comprising:

oxidizing the conductive material of the microelectronic substrate at a second rate greater rate than the first rate by applying an electrical current to the conductive material to form an oxidized material, wherein the conductive material is positioned on a face surface of the microelectronic substrate, and wherein applying the electrical current to the conductive material includes positioning first and second electrodes spaced apart from the face surface and disposing an electrolytic fluid between the face surface and the first and second electrodes, with both electrodes in fluid communication with each other and the electrolytic fluid; and

while applying the electrical current to the conductive material, engaging the microelectronic substrate with a polishing surface of a polishing pad and moving at least one of the microelectronic substrate and the polishing pad relative to the other to remove the oxidized material.

48. (Original) The method of claim 47, further comprising controlling an oxidation rate of the conductive material by controlling characteristics of the electrical current passing through the conductive material.

49. (Original) The method of claim 47, further comprising controlling an oxidation rate of the conductive material by controlling at least one of a frequency and an amplitude of the electrical current passing through the conductive material.

50. (Original) The method of claim 47, further comprising halting removal of material from the microelectronic substrate by halting a flow of electrical current through the conductive material.

51. (Original) The method of claim 47, further comprising:
selecting the electrolytic fluid to have no discrete abrasive elements; and
selecting the polishing pad to have no discrete abrasive elements.

52. (Original) The method of claim 47, further comprising selecting the electrolytic fluid to include chloride ions at a concentration of from about 50 ppm to about 5,000 ppm.

53. (Original) The method of claim 47, further comprising selecting the polishing pad to include a plurality of abrasive elements fixedly attached to the polishing pad at least proximate to the polishing surface.

54. (Original) The method of claim 47, further comprising selecting the electrolytic fluid to include a plurality of suspended abrasive elements.

55. (Original) The method of claim 47, further comprising selecting the conductive material to include a metal.

56. (Original) The method of claim 47, further comprising selecting the conductive material to include a semiconductor material.

57. (Original) The method of claim 47, further comprising selecting the conductive material to include a noble metal.

58. (Original) A method for removing material from a face surface of a microelectronic substrate, comprising:

engaging the microelectronic substrate with a polishing surface of a polishing pad;

electrically coupling a noble metal material of the microelectronic substrate to a source of electrical potential;

oxidizing at least a portion of the conductive material with an electrical current passing through the conductive material from the source of electrical potential by positioning first and second electrodes spaced apart from the face surface and disposing an electrolytic fluid between the face surface and the electrodes, with both the electrodes in fluid communication with each other and the electrolytic fluid; and

removing the portion of the conductive material from the microelectronic substrate by moving at least one of the microelectronic substrate and the polishing pad relative to the other.

59. (Original) The method of claim 58, further comprising selecting the microelectronic substrate to include platinum.

60. (Original) A method for removing material from a face surface of a microelectronic substrate, comprising:

engaging the microelectronic substrate with a polishing surface of a polishing pad;

passing an electrical current through a platinum material of the microelectronic substrate by positioning first and second electrodes spaced apart from the face surface and disposing an electrolytic fluid between the face surface and the electrodes, with both the electrodes in fluid communication with the electrolytic fluid;

oxidizing at least a portion of the platinum material by passing an electrical current through the platinum material from the source of electrical potential; and

removing the portion of the platinum material from the microelectronic substrate by moving at least one of the microelectronic substrate and the polishing pad relative to the other.

61. (Original) The method of claim 60, further comprising controlling an oxidation rate of the conductive material by controlling characteristics of the electrical current passing through the conductive material.

62. (Original) The method of claim 60, further comprising halting removal of material from the microelectronic substrate by halting a flow of electrical current through the conductive material.

63. (Original) The method of claim 60, further comprising:
selecting the electrolytic fluid to have no discrete abrasive elements; and
selecting the polishing pad to have no discrete abrasive elements.

64. (Original) The method of claim 60, further comprising selecting the electrolytic fluid to include chloride ions having a concentration of from about 50 ppm to about 5,000 ppm.

65. (Original) The method of claim 60 wherein electrically coupling the conductive material to the source of electrical potential includes positioning the first and second electrodes facing toward the face surface of the microelectronic substrate.

66. (Original) The method of claim 60, further comprising selecting the electrolytic fluid to include at least one of $(\text{NH}_4)_2\text{SO}_4$, H_2SO_4 , K_2SO_4 , MgSO_4 , and H_3PO_4 .

67. (Original) The method of claim 60 wherein removing material from the microelectronic substrate includes removing the material anisotropically in a direction generally transverse to the polishing surface of the polishing pad.

68. (Original) A method for removing material from a face surface of a microelectronic substrate, comprising:

engaging the microelectronic substrate with a polishing surface of a polishing pad;

removing a portion of a conductive material from the microelectronic substrate by moving at least one of the microelectronic substrate and the polishing pad relative to the other;

electrically coupling the conductive material to a source of electrical potential by positioning first and second electrodes apart from the face surface and disposing an electrolytic fluid between the face surface and the electrodes, with both the electrodes in fluid communication with each other and the electrolytic fluid; and

controlling an amount of conductive material removed from the microelectronic substrate by controlling a flow of electrical current to the conductive material while the microelectronic substrate is engaged with the polishing surface of the polishing pad.

69. (Original) The method of claim 68, further comprising oxidizing at least part of the portion of conductive material removed from the microelectronic substrate by passing the flow of electrical current through the conductive material before removing the conductive material from the microelectronic substrate.

70. (Original) The method of claim 68 wherein controlling a flow of electrical current includes selectively initiating and halting a flow of electrical current.

71. (Original) The method of claim 68 wherein controlling a flow of electrical current includes halting the flow of current when a selected quantity of the conductive material has been removed from the microelectronic substrate.

72. (Original) The method of claim 68 wherein controlling a flow of electrical current includes controlling an oxidation rate of the conductive material by

controlling at least one of a frequency and amplitude of the electrical current passing through the conductive material.

73. (Original) The method of claim 68, further comprising:
selecting the electrolytic fluid to have no discrete abrasive elements; and
selecting the polishing pad to have no discrete abrasive elements.

74. (Original) The method of claim 68, further comprising positioning the first and second electrodes to face toward the face surface of the microelectronic substrate.

75. (Original) The method of claim 68, further comprising selecting the conductive material to include a metal.

76. (Original) The method of claim 68, further comprising selecting the conductive material to include polysilicon.

77. (Original) A method for removing material from a microelectronic substrate, comprising:

engaging the microelectronic substrate with a material removal medium that includes a polishing pad having a polishing surface and an electrolytic fluid disposed adjacent to the polishing surface, the material removal medium having no discrete abrasive elements;

electrically coupling a conductive material of the microelectronic substrate to a source of electrical potential; and

removing a portion of the conductive material from the microelectronic substrate by passing an electrical current through the electrolytic fluid and the conductive material and moving at least one of the microelectronic substrate and the polishing pad relative to the other.

78. (Original) The method of claim 77, further comprising controlling an oxidation rate of the conductive material by controlling characteristics of an electrical current passing through the conductive material.

79. (Original) The method of claim 77, further comprising controlling an oxidation rate of the conductive material by controlling at least one of a frequency and an amplitude of an electrical current passing through the conductive material.

80. (Original) The method of claim 77, further comprising halting removal of material from the microelectronic substrate by halting a flow of electrical current through the conductive material.

81. (Original) The method of claim 77 wherein the microelectronic substrate has a face surface and wherein electrically coupling the conductive material to the source of electrical potential includes positioning first and second electrodes facing toward the face surface and disposing the electrolytic fluid between the conductive material and the electrodes with one electrode defining an anode and the other electrode defining a cathode.

82. (Original) The method of claim 77, further comprising selecting the conductive material to include a metal.

83. (Original) The method of claim 77, further comprising selecting the conductive material to include a doped semiconductor.

84. (Original) A method for removing material from a microelectronic substrate, comprising:

engaging the microelectronic substrate with a polishing surface of a polishing pad;

exposing the microelectronic substrate to a liquid having a concentration of chloride ions of from about 50 ppm to about 5,000 ppm;

electrically coupling a conductive material of the microelectronic substrate to a source of electrical potential; and

removing the portion of the conductive material from the microelectronic substrate by moving at least one of the microelectronic substrate and the polishing pad relative to the other while passing an electrical current through the conductive material.

85. (Original) The method of claim 84 wherein the conductive material is positioned on a face surface of the microelectronic substrate, and wherein electrically coupling the conductive material to a source of electrical potential includes facing first and second electrodes toward the face surface, with one of the electrodes defining an anode and the other electrode defining a cathode, and passing an electrical current through the liquid between the face surface and the first and second electrodes, with both the first and second electrodes in fluid communication with each other and the liquid.

86. (Original) The method of claim 84 wherein the conductive material includes platinum, and wherein the method further comprises selecting the liquid to have a chloride ion concentration of from about 100 ppm to about 5,000 ppm.

87. (Original) The method of claim 84, further comprising selecting the liquid to include $(\text{NH}_4)_2\text{SO}_4$, K_2SO_4 , MgSO_4 , H_3PO_4 , and/or H_2SO_4 .

88. (Original) The method of claim 84, further comprising selecting the liquid to have a pH of from about 1 to about 14 when the conductive material includes platinum, less than about 3 or greater than about 4 when the conductive material includes tungsten, and less than about 6 or greater than about 8 when the conductive material includes copper

89. (Original) The method of claim 84, further comprising oxidizing the conductive material.

90. (Withdrawn)
91. (Withdrawn)
92. (Withdrawn)
93. (Withdrawn)
94. (Withdrawn)
95. (Withdrawn)
96. (Withdrawn)
97. (Withdrawn)
98. (Withdrawn)
99. (Withdrawn)
100. (Withdrawn)
101. (Withdrawn)
102. (Withdrawn)
103. (Withdrawn)
104. (Withdrawn)

105. (Withdrawn)

106. (Withdrawn)

107. (Withdrawn)

108. (Original) A method for removing conductive material from a microelectronic substrate, the conductive material being capable of being removed from the microelectronic substrate at a selected rate when engaged with a polishing pad and subjected to a first force normal to a polishing surface of the polishing pad, the method comprising:

coupling the conductive material to a source of electrical potential;

oxidizing the conductive material of the microelectronic substrate by applying an electrical current to the conductive material to form an oxidized material while the microelectronic substrate is engaged with the polishing surface of the polishing pad; and

removing the oxidized material from the microelectronic substrate by applying a second force normal to the polishing surface of the polishing pad, the second force being less than the first force.

109. (Original) The method of claim 108 wherein the conductive material is positioned on a face surface of the microelectronic substrate, and wherein electrically coupling the conductive material to a source of electrical potential includes positioning first and second electrodes apart from the face surface, with one of the electrodes defining an anode and the other electrode defining a cathode, and disposing electrolytic fluid between the face surface and the first and second electrodes with the first and second electrodes in fluid communication with each other and the electrolytic fluid.

110. (Original) The method of claim 108, further comprising positioning the first and second electrodes to face toward the face surface of the microelectronic substrate.

111. (Original) The method of claim 108, further comprising selecting the conductive material to include copper.

112. (Original) The method of claim 108, further comprising selecting a substrate material of the microelectronic substrate to include porous silica, the substrate material being positioned to support the conductive material.

113. (Original) The method of claim 108, further comprising selecting a substrate material of the microelectronic substrate to have a dielectric constant of from about 1.5 to about 3, the substrate material being positioned to support the conductive material.

114. (Withdrawn)

115. (Original) A method for removing material from a face surface of a microelectronic substrate, comprising:

engaging the microelectronic substrate with a polishing surface of a polishing pad;

electrically coupling a conductive material of the microelectronic substrate to a source of electrical potential by positioning an anode and a cathode facing toward but spaced apart from the face surface of the microelectronic substrate, disposing an electrolytic fluid between the microelectronic substrate and the anode and cathode with the anode and cathode in fluid communication with each other and the electrolytic fluid, and coupling at least one of the anode and the cathode to the source of electrical potential;

oxidizing at least a portion of the conductive material by passing an electrical current from the source of electrical potential through the conductive material

while the microelectronic substrate is engaged with the polishing surface of the polishing pad; and

removing the portion of the conductive material from the microelectronic substrate by moving at least one of the microelectronic substrate and the polishing pad relative to the other.

116. (Original) The method of claim 115, further comprising selecting the conductive material to include at least one of copper, aluminum, platinum, rhodium, iridium, gold, polysilicon, titanium, titanium nitride, tantalum, tantalum nitride, tungsten, tungsten nitride, titanium silicon nitride, and tantalum silicon nitride.

117. (Original) The method of claim 115, further comprising controlling a rate at which the conductive material is removed by controlling a concentration of chloride ions disposed in the electrolytic fluid.

118. (Original) The method of claim 115 wherein controlling a concentration of chloride ions includes selecting the concentration to be from about 50 ppm to about 5,000 ppm.

119. (Original) An apparatus for removing material from a microelectronic substrate, comprising:

a substrate support configured to engage the microelectronic substrate;
and

a material removal medium positioned proximate to the substrate support, the material removal medium including a polishing pad having a polishing surface positioned to engage the microelectronic substrate during operation, the material removal medium further including a liquid disposed on the polishing pad, the material removal medium still further including at least one electrode positioned at least proximate to the substrate support and coupleable to a source of electrical potential, neither the polishing pad nor the liquid having discrete abrasive elements, at least one of the material removal medium and the substrate support being movable relative to the

other when the substrate support and the material removal medium engage the microelectronic substrate.

120. (Original) The apparatus of claim 119 wherein the liquid is selected to include at least one of $(\text{NH}_4)_2\text{SO}_4$, K_2SO_4 , MgSO_4 , H_3PO_4 , and H_2SO_4 .

121. (Original) The apparatus of claim 119, further comprising first and second electrodes positioned proximate to and spaced apart from the polishing surface of the polishing pad, with both the first and second electrodes facing toward a face surface of the microelectronic substrate when the substrate support engages the microelectronic substrate.